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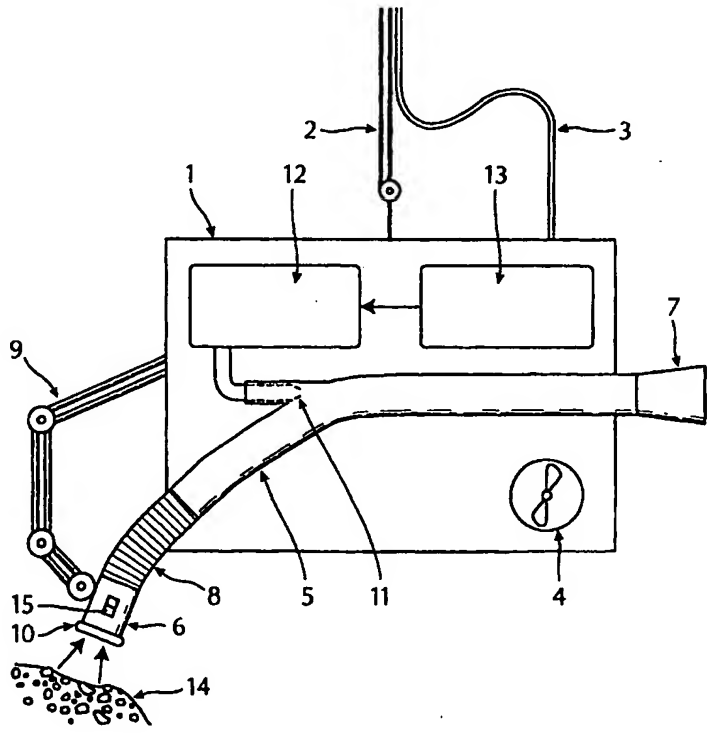
(54) Title: METHOD AND DEVICE FOR MOVING SUBSEA ROCKS AND SEDIMENTS



(57) **Abstract:** Method for moving subsea rocks and sediments, also at significant depths, e.g. in connection with removal of protective rocks around subsea installations where maintenance is to be conducted, by which equipment comprising a tubing with an ejector nozzle is arranged completely externally in relation to the tubing on a standard, remote controlled submarine (ROV). The ejector nozzle is connected to a preferably hydraulic powered water pump; the water pump is run by means of the energy supply to the ROV, so that the ejector nozzle produces a pressure gradient through said tubing. The inlet end of said tubing is contacted with rocks and sediments to be moved with the result that said rocks and sediments are sucked into the tubing at its inlet end and blown out of its outlet end. The invention also relates to a device to conduct the method, which device is arranged on an ROV and comprises a tubing (5) through which the sediments (14) are transported, an ejector nozzle (11) arranged externally in relation to the tubing (5), and a water pump (12, 13) connected to the ejector nozzle. All energy is supplied through the cable(s) (3) to the surface which constitutes the ROV's ordinary energy supply.

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Method and device for moving subsea rocks and sediments

The present invention relates to a method of the kind described in the preamble of claim 1. The invention further relates to a device for performing such a method, as described by the preamble of claim 3.

Background

For work at subsea oil and gas installations or in connection with such installations, e.g. maintenance work, there is often a need to move rocks and particulate material that partly covers the body that is to be repaired. The body can be a pipeline, valve housing and the like.

In a similar way it may arise a need to remove sediments in connection with new installations on the sea bottom, or for removal of accumulated drill cuttings at platforms or the like.

Similar needs may also occur in connection with subsea work, such as at harbour works or barrage or quay structures.

Previously known technology

The most common way to remove sediments in connection with subsea work, is to utilize large "fans", large and heavy suction devices with a high power consumption and specially designed excavators. Disadvantages are that they require a lot of power and/ or other resources, they require large surface vessels, have a limited versatility, are as good as stationary, or they are not at all suited for deep waters.

NO patent No. 302.043 describes a dredge designed for subsea operations, especially to remove or move drill cuttings. The dredge comprises a motor, a pump device and an ejector. The motor is designed to run the pump which in its turn provides a stream of water to the ejector. The ejector is positioned in a tubing through which the cuttings or the like are supposed to be transported. The apparatus is designed to rest on the sea bottom and to receive energy from the surface, while the inlet end of the tubing is intended to be moveable e.g. with the aid of a remote controlled mini submarine, a so called ROV.

This apparatus is not suited to move sediments with relatively large rocks, mainly because the pipeline has an effective loss of diameter due to the ejector's design and position. Furthermore it has geographically a very limited work range, as it is designed

to rest at the sea bottom, even though the pipeline is supposed to be somewhat moveable.

Japanese patent applications Nos. 043 25 799 A and 043 25 800 A describes an ejector pump system where the ejector is positioned mainly outside the pipeline so that the ejector does not reduce the effective diameter of the pipeline. From the abstract of these patent applications it is not possible to see what kind of utilizations these systems are intended for. Neither are there any indications of dimensions or power requirements for these systems.

Objectives

It is an object of the present invention to provide a method for transportation of rocks and sediments under water, especially in deep waters.

It is a particular object to provide a method for transportation of rocks with a typical maximum diameter of about 200 mm.

It is further an object to provide an apparatus for performing said method, which apparatus should be versatile in its use, especially in the way that it should be easy to move around down at the sea bottom.

It is still further an object to provide such an apparatus which is easy to control, and which does not require large amounts of energy to be supplied from the surface, but which can utilize the standard power supply available on an ROV.

The invention

These and other objects are achieved through the method according to the invention, which is characterized by the features defined by claim 1. Preferred embodiments of the invention are disclosed by the dependent claims related to claim 1.

The above mentioned object are also achieved through the apparatus according toclaim 3, while preferred embodiments of the invention are indicated by the dependent claims related to claim 3.

In the following an example of an apparatus according to the invention is described in further detail with reference to the accompanying drawing.

Fig. 1 is a schematic view of a preferred embodiment of an apparatus according to the invention,

Fig. 1 shows in a very simplified form a remote controlled submarine (ROV) 1 with a suspension member 2 and a power cord 3. The suspension member 2 and the power cord 3 both extend up to the sea surface (not shown). The ROV 1 is also provided with a number of propellers 4 to enable it to move, one of which is shown in the drawing.

Arranged on the ROV 1 is a tubing 5 with an inlet 6 and an outlet 7. The tubing 5 may have at least one flexible section 8, permitting the inlet 6 of the tubing to be moved by means of a manipulator 9 that can be controlled independently of the ROV. The edge 10 of the inlet 6 is rounded to minimize loss at the inlet. The outlet 7 is shaped as a diffusor, also to minimize loss and thereby the power requirement. The tubing 5 is preferably designed with a substantially even cross section from its inlet to its outlet and without any sharp bends where large rocks might be trapped.

An ejector nozzle 11 is attached externally to the tubing 5 so that it does not diminish the diameter of the tubing. The ejector nozzle 11 provides a powerful water jet supplied from a water pump 12 powered by a hydraulic member 13. The ejector nozzle 11, the water pump 12 and the hydraulic member 13 together constitute the power assembly or the "motor" for the apparatus according to the invention.

Close to the inlet 6 of the tubing a "backflushing" arrangement (not shown) may preferably be arranged to blow out rocks which are too large or clogged sediment that might get stuck in the inlet. Further an opening 15 may be provided through the inlet 6 or through the tubing 5 close to the inlet, the size of which is preferably adjustable, for the purpose of controlling the suction at the inlet point and reducing its tendency to get stuck in fine sediments.

The apparatus according to the invention may be primarily manufactured from plastic material with a specific weight close to that of water, so that it is easy for an ROV to carry.

All the mentioned units are fixed or moveable on the ROV 1 and the power consuming components all receive power through the ROV's standard power supply 3.

The drawing also indicates a collection of rocks 14 in the process of being moved through the tubing 5 by means of the described mechanism.

Calculation example

In the following calculation example it is presupposed that the apparatus is attached to a ROV with an available 30 kW (hydraulic) effect. It is further presupposed that the

hydraulic motor and the water pump have a total efficiency of 0.64. In that case the water pump will be able to provide 3000 l/ min. at a pressure of 4.0 bar. Rocks used to protect structures at the sea bottom usually have a largest diameter d_{max} = 150 mm. If the tubing has a diameter of 250 mm and a length of 8.0 m, the following theoretical data follows:

Table 1

Velocity before mixing chamber	5.0 m/s	
Velocity after mixing chamber	6.0 m/s	
Required velocity	4.0 m/s	
Motive power (lifting height)	1.50 m	
of which inlet loss	0.26 m	(k= 0.2)
frictional loss	0.68 m	(k= 0.017)
outlet loss	0.56 m	(k= 0.3)
Capacity transport of 150 mm rocks	20 t/ hour (confirmed by model tests)	
Power consumption ROV	30 kW	
Power from water pump	19 kW	
Net effect used by the device	4 kW	

Example of practical embodiment

In a commission during the summer of 1999 1500 m^3 of rocks (d_{max} = 150 m) were moved with an apparatus according to the present invention. The commission took place in Tengsfjorden, at a pipeline for oil at a 540 m depth. An ROV of type Perry-XL was used. 100 l/ min. of hydraulic oil at a pressure of 180 bar was available for running the water pump, which corresponds to 29 kW. The tubing, made from PE-plastic, had a total length of 10 m, and an internal diameter of 250 mm. Only a minimal wear could be observed on the tubing, It was observed, however, that rocks from time to time got stuck due to unintended unevenness in the tubing. The invention is unique in the sense that it allows rocks to be moved with much lighter equipment than that previously available on the market, and at depths where it has not been possible to conduct this kind of task. The above-referred commission confirms that the invention is practically feasible.

Claims

1. Method for moving subsea rocks and sediments, also at significant depths, e.g. in connection with removal of protective rocks around subsea installations where maintenance is to be conducted,

characterized in that equipment including a tubing with an ejector nozzle is arranged completely externally in relation to the tubing on a standard, remote controlled submarine (ROV), which ejector nozzle is connected to a preferably hydraulic powered water pump, that said water pump is run by means of the energy supply to the ROV, so that the ejector nozzle produces a pressure gradient through said tubing, and that an inlet end of said tubing is located with rocks and sediments to be moved with the result that said rocks and sediments are sucked into the tubing at its inlet end and blown out of its outlet end.

2. Method according to claim 1,

characterized in that the inlet end of the tubing is movable by means attach able to the ROV.

3. Method according to claim 1,

characterized in that said equipment is principally made from plastic materials with a density close to the density of water.

4. Device for moving subsea rocks and sediments, including at significant depths. e.g. in connection with removal of protective rocks around subsea installations where maintenance is to be conducted,

characterized in that it includes a tubing (5) through which the rocks and sediments (14) is transported with the aid of an applied pressure gradient, that the pressure gradient is maintained with an ejector nozzle (11) arranged completely externally in relation to the tubing (5), that the ejector nozzle (11) receives water from a water pump (12, 13) connected therewith, and that the entire device is supportable by an ROV (1) and that all required energy is supplied through that cable or those cables (3) to the surface with which the ROV (1) is equipped.

5. Device according to claim 4,
characterized in that an inlet mouth piece (6) of the tubing (5) is arranged with a rounded edge (10) in order to reduce inlet loss.

6. Device according to claim 4,
characterized in that the tubing (5) comprises an outlet end (7) shaped as a diffusor in order to reduce outlet loss.

7. Device according to claim 4,
characterized in that the cross-section of the tubing (5) is substantially even from the inlet moth piece (6) to the outlet end (7) and that bends on the tubing have sufficiently large radius or small angle to avoid rocks from getting stuck in the tubing.

8. Device according to claim 4,
characterized in that the inlet mouth piece (6) is provided with a backflush nozzle for flushing out rocks that tend to get stuck in the mouth piece, or to loosen clogged sediment.

9. Device according to claim 4,
characterized in that downstream and close to the inlet mouth piece (6) an aperture (15), preferably with adjustable size, is arranged, through which some water will flow, thereby controlling the suction force in the mouth piece and reducing its tendency to get stuck in fine sediments.

10. Device according to claim 4,
characterized in that the device is substantially made from plastic materials with a density close to the density of water, so that it may easily be supported by an ROV.

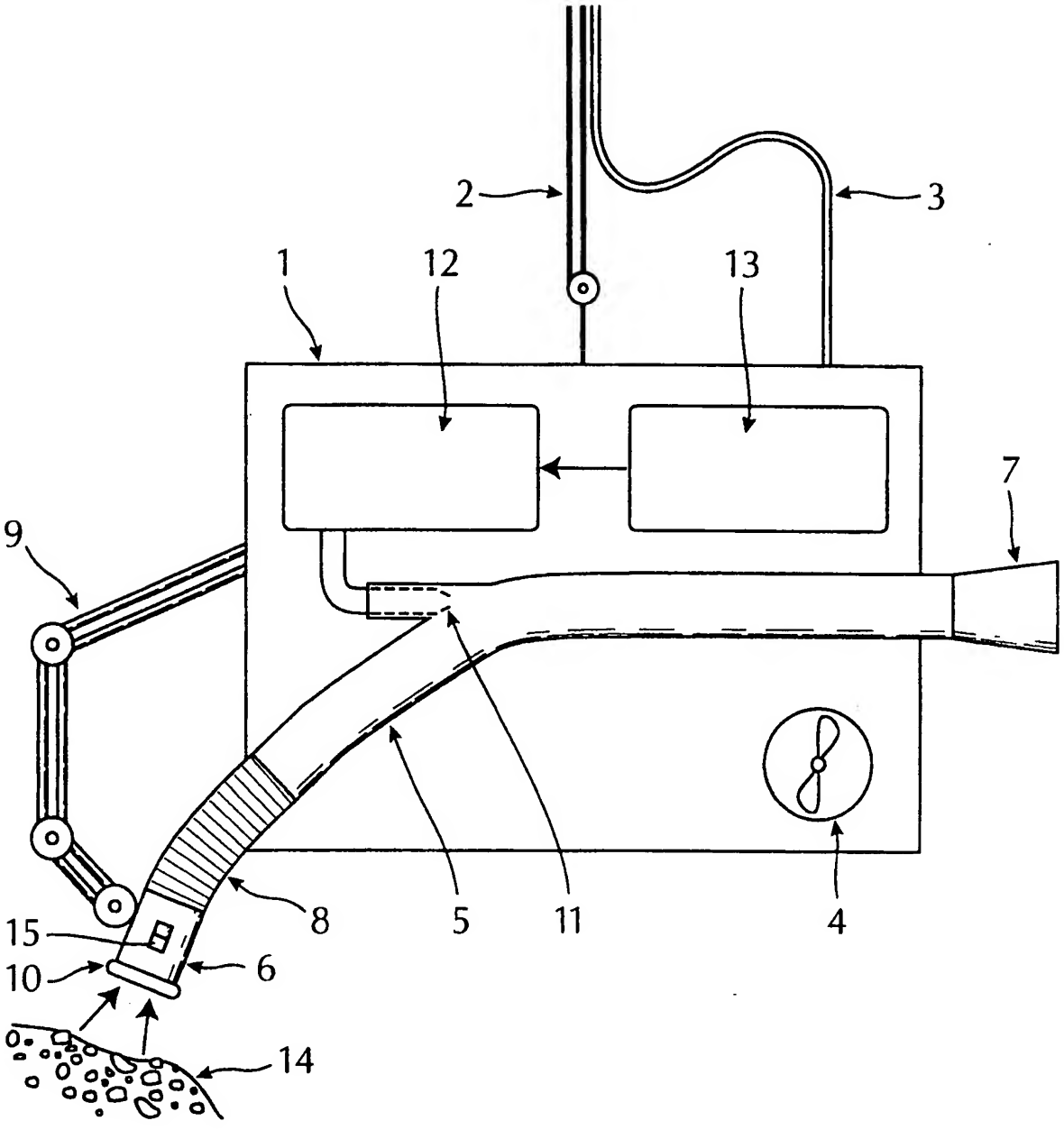

Fig. 1

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